201-15091

HPV

DATA SUMMARY AND TEST PLAN

FOR

1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 2-(2-hydroxyethoxy)ethyl 2-hydroxypropyl ester

(e.g. Diester/ether diol of tetrabromophthalic anhydride)

CAS No. 77098-07-8

Prepared by

Albemarle Corporation
Baton Rouge, LA

And

Great Lakes Chemical Corporation
West Lafayette, IN

February 4, 2004

1.0 INTRODUCTION

1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 2-(2-hydroxyethoxy)ethyl 2-hydroxypropyl ester (CAS# 77098-07-8) is also known as the diol ester of tetrabromophthalic anhydride (TBPA Diol). TBPA Diol is sponsored under the U.S. Environmental Protection Agency's voluntary High Production Volume Program by its two manufacturers, Albemarle Corporation and Great Lakes Chemical Corporation. TBPA Diol is manufactured in a closed system by the reaction of tetrabromophthalic anhydride with diethylene glycol followed by reaction with propylene oxide. TBPA Diol is used solely as a flame retardant, and is sold under the trade names Saytex® RB-79 and Great Lakes PHT4-Diol.

2.0 STRUCTURE AND PROPERTIES

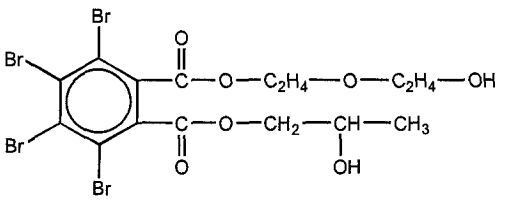

Figure 1. 1,2-Benzenedicarboxylic acid, 3,4,5,6-tetrabromo-, 2-(2-hydroxyethoxy)ethyl 2-hydroxypropyl ester

The structure of TBPA Diol ($C_{15}H_{16}O_7Br_4$) is shown in Figure 1. It's molecular weight is 627.90. The commercial product, which consists of the TBPA Diol monomer and its oligomers, is an amber viscous liquid at room temperature. TBPA Diol's estimated (EPIwin, v3.04) water solubility and vapor pressure are 0.05 mg/L and 2.37 x 10-14 mm Hg, respectively, at 25 deg C. Albemarle Corporation's technical data sheet reports the following solubilities (Wt. %, 25°C):

Water	< 0.1
Acetone	> 100
Methanol	< 0.1
Toluene	> 100
HCFC 141b	> 6
HCFC 245fa	> 23
CFC -11	< 1

3.0 APPLICATIONS

TBPA Diol is used to flame retard rigid polyurethane foam, and urethane elastomers and coatings. TBPA Diol chemically reacts with the urethane and becomes a part of the polymer backbone. Typical levels used to flame retard urethanes are 5-15 %. The end products in which these urethane foams, elastomers and coatings are used include building insulation and specialty coatings.

4.0 TOXICOLOGY DATA SUMMARY

All tests were performed on the commercial product unless otherwise specified.

4.1 Environmental Fate

TBPA Diol's measured and predicted environmental fate parameters are provided in Table 1.

TBPA Diol is predicted to partition in the environment primarily to soil and to a lesser extent to water. Partitioning to sediment and air are expected to be minimal. TBPA Diol's estimated half-life in soil is 120 days, and therefore may be persistent in that matrix. TBPA Diol may also be persistent in water and sediment, but not air. TBPA Diol may have potential to leach through soil and enter groundwater due to its low Log Koc. TBPA Diol is not expected to volatilize from water based on its river and lake volatilization half-lives and air-water partition coefficient. Sewage treatment plants are not predicted to remove TBPA Diol from the influent either through biodegradation or partitioning to sludge.

Using EPA's PBT Profiler software, TBPA Diol is expected to be persistent, and is not expected to be bioaccumulative in the food chain and is not expected to exert chronic toxicity to fish due to its very low water solubility. Thus, TBPA Diol does not fulfill EPA's criteria of a Persistent, Bioaccumulative and Toxic (PBT) chemical.

TABLE 1. Environmental Fate Parameters for TBPA Diol.

Parameter	Estimation Program or Test Result	Result
Photodegradation	-	Not likely to be a significant route of environmental degradation due to low vapor pressure
Hydrolysis	Estimated (EPI win, V.3.04)	Total Kb for pH > 8: 5.8 L/mol-sec Kb Half-life at pH8: 1.4 days Kb Half-life at pH7: 13.6 days
Distribution	Estimated (EPI win, V.3.04)	Level III Fugacity Model predicts at emissions to Air, Water, Soil and Sediment of 1,000, 1,000, 1,000 and 0 kg/hr, respectively: Air 0.0008%, Water 15.6 %, Soil 82.3%; Sediment 2.04%.
	PBT Profiler	Air 0%; Water 9%; Soil 90%; Sediment 2%
Atmospheric Oxidation	Estimated (EPI win, V.3.04)	Overall OH Rate Constant = 30.5 x 10-12 cm3/molecule-sec Half-Life = 0.35 Days (12-hr day; 1.56 x 10+6 OH/cm3) Half-Life = 4.2 Hrs
Henry's Law Constant	Estimated (EPI win, V.3.04)	2.2 x 10-21 atm-m3/mole at 25 °C 9.1 x 10-20unitless at 25 °C
Soil Koc	Estimated (EPI win, V.3.04)	10
Log Kow	Estimated (EPI win, V.3.04)	3.82
Air-Water Partition Coefficient	Estimated (EPI win, V.3.04)	1.1x10-14
Biomass to Water Partition Coefficient	Estimated (EPI win, V.3.04)	1353
Volatization from Water	Estimated (EPI win, V.3.04)	Half life: 6.1x10+8 years (River); 6.6x10+9 years (Lake)
Sewage Treatment Plant Fugacity Model	Estimated (EPI win, V.3.04)	Total Removal: 22.95%, Total Biodegradation: 0.26%, Primary Sludge: 12.96%, Waste Sludge: 9.73%, Final Water Effluent: 77.05%
Level III Fugacity Model	Estimated (EPI win, V.3.04)	At Emissions to Air, Water, Soil and Sediment of 1,000, 1,000, 1,000 and 0 kg/hr, respectively: Fugacity (atm): Air 4.39 x 10-20, Water 1.6 x 10-21, Soil 1.4 x 10-21, Sediment 1.6 x 10–21 Reaction (kg/hr): Air 3.27, Water 358, Soil 1.9 x10+3, Sediment 12 Advection (kg/hr): Air 0.4, Water 743, Soil 0, Sediment 2 Reaction (%): Air 0.1, Water 12, Soil 63, Sediment 0.4 Advection (%): Air 0.01, Water 25, Soil 0, Sediment 0.06
Biodegradation	Estimated (EPI win, V.3.04)	Not expected to biodegrade fast
Half-lives	Estimated (EPI win, V.3.04) and based on Biowin (Ultimate) and AOPwin	Air: 8.4 Hr Water: 1440 Hr Soil: 1440 Hr Sediment 5760 Hr
	PBT Profiler	Air: 0.54 Days Water: 60 Days Soil: 120 Days Sediment 540 Days Overall Persistence 150 Days

4.2 Ecotoxicology Data

TBPA Diol's estimated properties are provided in Table 2. TBPA Diol's estimated and measured (*Lepomis macrochirus*) fish LC50 values are in good agreement. TBPA Diol is not expected to bioconcentrate and its estimated chronic toxicity value in fish is below that of its estimated water solubility. Thus, TBPA Diol is not expected to concentrate in higher organisms to levels that may be toxic.

Table 2. Ecotoxicology parameters for TBPA Diol.

Parameter	Estimation Program or Test Result	Result
Log Kow	Estimated (EPI win, V.3.04)	3.82
Water Solubility (mg/L)	Estimated (EPI win, V.3.04)	0.05
Fish LC50 96 Hr (mg/L)	Estimated (ECOSAR)	9.9
Dapnid LC50 48 Hr (mg/L)	Estimated (ECOSAR; Esters)	10.7
Green Algae EC50 96 Hr (mg/L)	Estimated (ECOSAR; Esters)	0.8
Fish ChV (mg/L)	Estimated (ECOSAR; Esters)	1.1
	PBT Profiler	1.1
Green Algae ChV (mg/L)	Estimated (ECOSAR; Esters)	0.7
Fish 14-day (mg/L)	Estimated (ECOSAR; Neutral Organic SAR)	21.5
Fish LC50 96 Hr (mg/L)	Measured (GLCC 1982)	12
Bioconcentration (BCF)	Estimated (EPI win, V.3.04)	39
	PBT Profiler	39

Actual test results from a 96-hour LC50 study in fish are as follows. Stock solutions of TBPA Diol were prepared by dissolving the test article in acetone and diluting in water to the final concentrations (0 – 100 mg/L). All test solutions were cloudy after preparation. Bluegill sunfish (Lepomis macrochirus) were exposed to the test concentrations for 96 hours. The 96-hour LC50 was 12 mg/L. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3 Mammalian Toxicology Data

TBPA Diol was not acutely toxic to rats or rabbits by the oral or dermal routes, respectively. TBPA Diol was not irritating to the skin or eyes of rabbits. TBPA Diol was not mutagenic in the Ames test.

4.3.1 Acute Toxicity

4.3.1.1 Oral Toxicity

Five male and five female Sprague-Dawley rats were administered a single dose of 10 g TBPA Diol/kg body weight as an emulsion in corn oil. Observations were recorded during the first 4 hours post-dosing, at 24 hours and daily thereafter for 14 days. No deaths occurred. The LC50 oral was > 10 g/kg. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3.1.2 Dermal Toxicity

A single application of TBPA Diol, 20 g/kg, was applied to the clipped intact or lightly abraded back and flank skin of two male and two female New Zealand albino rabbits. The test site was wrapped with an airtight occlusive wrap for the 24-hour exposure period. The rabbits were observed at 24 hours and daily thereafter for a total of 14 days. Body weights were recorded initially and at 7 and 14 days post dosing. None of the rabbits died and all appeared normal during the observation period. The LD50 dermal was > 20 g/kg. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3.1.3 Inhalation Toxicity

Five male and five female Charles River CD rats were exposed for one hour to an essentially saturated atmosphere (0.008 mg/L) of TBPA Diol. Observations were made during the one-hour exposure and daily thereafter for 14 days. Body weights were recorded prior to the exposure and periodically thereafter. All rats were necropsied at the end of the 14-day observation period. No deaths occurred during the 14-day observation period. No signs of toxicity were observed. The one-hour LC50 was > 0.008 mg/L. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3.1.4 Eye Irritation

To assess the irritant and/or corrosive effects on the eyes of rabbits, TBPA Diol was instilled into the right eye of each of six rabbits. Observations were recorded at 1, 24, 48 and 72 hours after treatment. No positive ocular scores were recorded. The test article was not irritating to the eyes. This study was conducted according to Good Laboratory Practices. (Mallory et al. 1986. Primary Eye Irritation. PH 421-ET-009-86. Saytex RB-79 Diol. Lot # 19-1941-B. Pharmakon Research International, Inc. Waverly, PA. Sponsor: Ethyl Corporation, Baton Rouge, LA)

The right conjunctival sacs of the right eyes of three male and female New Zealand albino rabbits were instilled with 0.1 ml of TBPA Diol. Redness and chemosis of the conjunctiva were observed for 72 hours. Discharge was noted in one rabbit at 24 hours. TBPA Diol was not a primary eye irritant under the conditions of this test. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3.1.5 Skin Irritation

The backs of three male and female New Zealand albino rabbits were clipped. The skin of three were abraded. A single application of TBPA Diol (0.5 ml) was made to the back of each rabbit under a gauze patch and wrapped with an airtight occlusive wrap. The skin was examined at 24, 48 and 72 hours post-dosing. No irritation was noted on the intact skin. Erythema and edema were observed on the abraded skin. The primary irritation index, according to the method of Draize, was 0.7. TBPA Diol was not a primary skin

irritant under the conditions of this test. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

4.3.2 Mutagenicity

TBPA Diol was tested in *Salmonella typhimurium* strains TA1535, TA1537, TA98 and TA100 with and without metabolic activation (Arochlor 1254 induced rat liver S-9 fraction). Dose levels were 0, 50, 100, 500, 1000 and 5000 ug/plate. TBPA Diol was not soluble at the highest dose. Each dose was tested in triplicate. An untreated control, solvent control and positive control were tested concurrently. TBPA Diol was toxic to all strains at the highest dose, and did not cause a dose related increase in mutant colonies in any strain either with or without metabolic activation. TBPA Diol was not genetically active. This study was performed according to Good Laboratory Practices. (Johnson and Mulholland. 1985. Genetic Toxicology *Salmonella*/Microsomal Assay. Ames 091-#089. Saytex RB-79. Genetic Toxicology Laboratory. Ethyl Technical Center. Baton Rouge, LA.)

TBPA Diol was examined for mutagenic activity at a number of concentrations in a series of in vitro microbial assays with *Salmonella* and *Saccharomyces* organisms both directly and in the presence of liver microsomal enzyme preparations from Arochlor-induced rats. The results were all negative. TBPA Diol was not mutagenic under the conditions of the test. (PHT 4-Diol Summaries of Toxicity Data. 1981. Great Lakes Chemical Corporation, West Lafayette, IN)

5.0 TESTING PLAN

TBPA Diol's existing data is limited to acute toxicity and irritation studies in mammals, a gene mutation study, and an acute toxicity study in one aquatic trophic level. Estimated values are available for physical properties, aquatic toxicity, bioconcentration, biodegradation, abiotic degradation, environmental partitioning, and fugacity.

Table 3 outlines the proposed testing on TBPA Diol. Measurement of TBPA Diol's water solubility (as a function of pH), vapor pressure and octanol water partition coefficient are proposed. The following degradation studies are proposed in light of TBPA Diol's predicted persistence, its potential to remain in sewage treatment effluent and its predicted distribution to soil: Hydrolysis as a Function of pH (OPPTS 835.2110) and a biodegradation study. The appropriate biodegradation test will be determined at a later date. Photodegradation testing is not indicated due to TBPA Diol's minimal partitioning to air.

Also proposed are acute aquatic toxicity testing in daphnia (TSCA 40 CFR 797 1300; OECD 202, Part1) and green algae (TSCA 40 CFR 797 1050; OECD 201).

For mammalian toxicity, an *in vitro* Chromosome Aberration Test (OPPTS 870.5375) and a repeated dose toxicity study in the rat are proposed. An oral repeated dose study in rats is proposed because no data exists for this endpoint. The oral route of exposure is

proposed as this is commonly used in toxicology studies, and limited absorption via the dermal and inhalation routes is anticipated. TBPA Diol has a molecular weight over 600 and limited solubility; both of these characteristics will limit skin penetration. Its estimated vapor pressure is so low as to not present an inhalation hazard. The need for additional testing, including developmental and/or reproducitive, would be determined after evaluation of the results from the repeated dose study.

Timing for completion of the proposed testing in by the end of 2007.

Table 3. Testing proposed for TBPA Diol.

Study Type	Data Available	Data Acceptable	Estimation Available	Testing Proposed
Physical/Chemical				
Melting Point	Y	Y	Y	N
Boiling Point	Y	Y	Y	N
Vapor Pressure	N		Y	Y
Water Solubility	N		Y	Y
Environmental Fate				
Photodegradation	N		Y	N
Stability in Water (Hydrolysis)	N		Y	Y
Biodegradation	N		Y	Y
Transport (Fugacity)	N		Y	N
Ecotoxicity				
Acute Toxicity to Fish	Y	Y	Y	N
Acute Toxicity to Aquatic Invertebrates	N		Y	Y
Toxicity to Aquatic Plants	N		Y	Y
Toxicology Data				
Acute Toxicity	Y	Y	N	N
Repeated Dose Toxicity	N		N	Y
Genetic Toxicity – Mutation	Y	Y		N
Genetic Toxicity – Chromosome Aberration	N		N	Y
Developmental Toxicity	N		N	TBD*
Reproductive Toxicity	N		N	TBD

*To Be Determined